ON THE USE OF ELECTRO-MAGNETS IN THE EXTRACTION OF METALLIC BODIES FROM THE TRACHEA AND BRONCHI, WITH REPORT OF CASES.*

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Electro-magnets have been employed in a very limited number of cases in the extraction of foreign bodies from the deeper air-passages. With the perfection of the bronchoscope the use of magnets has rightly fallen more and more into the background. It is the purpose of this paper to report two cases in which the magnet was tried, and to point out that there still remains a limited field in which magnets may be advantageously employed.

In the literature eleven cases are recorded in which extraction by electro-magnets was undertaken. Seven of these cases were successful and four resulted in failure. To this list should be added the brilliant case which Dr. Lynch[1] has reported to-day, and one success and one failure of my own.

Garel,[2] in February, 1901, reported the case of a child, 18 months old, in which a nail had been lodged in the right bronchus for two months. A radiogram showed the nail head-up. A high tracheotomy was made and while the incision was held open with retractors an eye magnet was placed in the opening of the air passage. The nail became dislodged and instantly attached itself to the magnet. The nail was 2¼ inches long (6 cm.) and the magnet had attracted it through a distance of from 5 to 6 cm. (The child recovered.)

Piechaud's[3] case was recorded during the same year as that of Garel. A nail had become lodged in the left bronchus of a child 3½ years of age, and had been *in situ* for about six weeks.

A metal sound, curved on the end, was introduced through a tracheotomy, and was guided into the bronchus. The proximal end of the rod was then brought in contact with an electro-magnet and the nail was thereby attracted to the distal end, and successfully removed.

Two years later, Lermoyez and Guisez[4] reported the case of a man 26 years of age who had inspirated a small carpet tack eight weeks before. A radiogram at first revealed the tack (1 cm. long, with a head ½ cm. in diameter) in one of the divisions of the right bronchus. After an unsuccessful bronchoscopic examination, the tack passed further down and subsequently lower bronchoscopy showed the tack 1 to 2 cm. from the orifice of a bronchus of the third order. A specially constructed electro-magnet was then introduced through the tracheotomy incision and the tack was removed at the first attempt. The whole procedure did not require five minutes. (Recovery.)

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In September, 1904, Hosmer[5] reported the removal of a shingle nail from the left bronhcus of a child. The nail which had been *in situ* for 13 days was extracted by an electro-magnet provided with a long tip which was introduced through a tracheal incision. (Recovery.)

Burk[6] records the case of a child who had inspirated an iron screw eleven days before. The screw was first located in the left main bronchus but extraction with a bronchoscope failed at the first attempt. A radiogram subsequent to this examination showed that the foreign body had lodged in a lateral bronchus, but lower bronchoscopy failed to reveal its presence. Thereupon an elongated electro-magnet was introduced through, and 2 cm. beyond the bronchoscope, and the screw was removed without difficulty. (Recovery.)

The case of Dr. P. H. Hickey[7] was a very unusual one. A child, 3 years old, inspirated a steel safety pin. The x-ray examination showed the pin in the trachea immediately below the larynx. Tracheotomy failed to expose the pin and the fluoroscope showed that it had passed downward until its lower end was in the right bronchus. "The child was placed under a giant magnet, the tip of the magnet being placed over the locality against the chest wall where the rays showed the pin was located. The giant magnet was then moved in the direction of the child's head and a slight cough showed that the pin was moving with the magnet. The tracheotomy tube was removed as the tip of the magnet approached the neck and the pin was pulled up through the trachetomy wound." Recovery. The pin had been in the bronchus for about thirty-six hours.

Martin[8] reported the case of a boy, 8 years old, in whose right bronchus a screw 1¼ inches long had been lodged for five months. Subsequent to the inspiration of the foreign body the patient had developed an abscess of the lung which had been drained through a resected rib, but the radiogram showed that the foreign body had not been removed during this operation. Under the guidance of the x-rays, a large forceps was passed through the external opening to the screw. A giant magnet was then brought into contact with the handle of the forceps and the screw was pulled out through the attraction of the magnet. Recovery.

In two unfortunate cases Massei[9] was unable to extract foreign bodies by the aid of an electro-magnet. In the first patient, aged 3 years, a glass-headed pin was lodged in a bronchus, and in the second case a nail had become impacted (forty days) in the right bronchus of a boy of 8 years.

An unsuccessful case was reported by Brokaw[10], and one by Hubbard.[11] In the latter case an upholster tack had become lodged in the left bronchus of a child of 9 years. Attempts at extraction with a magnet were unavailing as the foreign body was impacted.

Brokaw's experience was almost identical with that of Hubbard, but he later succeeded in withdrawing the foreign body with a forceps introduced through an endoscopic tube.

REPORT OF AUTHOR'S CASES.

The following case presents some very interesting and unusual features:

Case 1: The patient, S. R., male, aged 6 years, was first seen in consultation with Dr. F. Leever, on August 22, 1912. His parents stated that about three and a half years ago he was supposed to have swallowed a metal screw. The stools had been watched but the foreign body had not been found. No particular symptoms were noted at first, but after some time the child suffered frequently with croupy cough and was treated for bronchitis. In February, 1912, he went through a severe attack of pneumonia, lasting seven weeks. After the acute stage had passed he came under the care of Dr. Leever who found a consolidation of the lower lobe of the left lung. This failed to resolve during the next three months. During this period he had a very protracted cough with mucoid expectoration containing at times traces of blood, and accompanied by a septic, irregular fever, ranging from normal to 103°, 104° and became "reduced to a skeleton," (weight 37½ lbs.). In the course of his illness the child developed clubbed fingers and toes, as well as an inguinal hernia.

On June 8, 1912, he suddenly expectorated a large amount of foul-smelling pus, slightly streaked with blood. After this, expectoration became very profuse, as much as 30 ounces a day, and the child always had a pus-basin with him. Repeated examinations for tubercle bacilli were negative. After a time the general condition improved somewhat so that the child was able to walk.

The diagnosis of an unresolved pneumonia with abscess formation was made by Dr. Leever and Dr. Lamb. Accordingly, on August 22, 1912, a radiogram was made by Dr. Lange. This showed a consolidation of the left lower lobe of the lung, in which an abscess cavity containing a foreign body (a screw?) could be seen. It lay head-downward at the termination of the left bronchus, opposite the fourth rib anteriorly and the seventh rib posteriorly. (Figure 1.)

On August 24, 1912, under general anesthesia, (atropin hypodermically) upper bronchoscopy was undertaken. Owing to the dyspnea and profuse secretion this was soon abandoned. A tracheotomy was then made through which a bronchoscope was introduced into a large abscess cavity, at the termination of the left bronchus. A large amount of pus was pumped, mopped and coughed out through the tube, but the secretion was so profuse that after prolonged search the examination was discontinued and a tracheotomy tube was inserted.

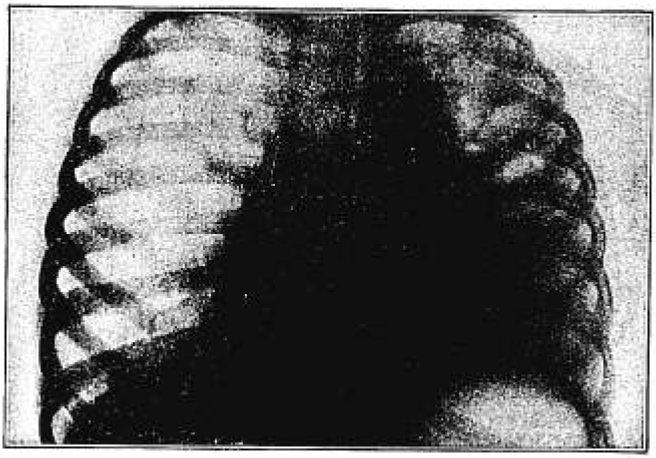

Figure 1. Radiogram showing an abscess of the left lung containing a metal screw, (retouched).

Following this unsuccessful bronchoscopy, the giant-magnet designed by Dr. Ranly[12] was procured. This magnet, with a lifting power of 6000 pounds is provided at one pole with a flexible extension in the shape of a heavy chain through which the magnetic force may be applied, where desired. (Figure 2.)

In addition to this, a tracing was taken from the x-ray plate, according to which a solid steel bar was patterned so that it would correspond to the line of the trachea and left bronchus. This rod was 9¼ inches long and ¼ inch in diameter and was flattened on the convex side so that it would not obstruct the right bronchus. (Figure 3.)

On August 29, 1912, under local anesthesia, (reinforced by atropin), lower bronchoscopy was again tried, but owing to the profuse secretion, again failed as before.

A steel tube was next passed through the bronchoscope into the abscess cavity and was then connected with the magnet, but this failed to draw out the foreign body. The bronchoscope was then removed and the solid steel bar, guided by touch, was passed through the trachea and left bronchus into the abscess cavity.

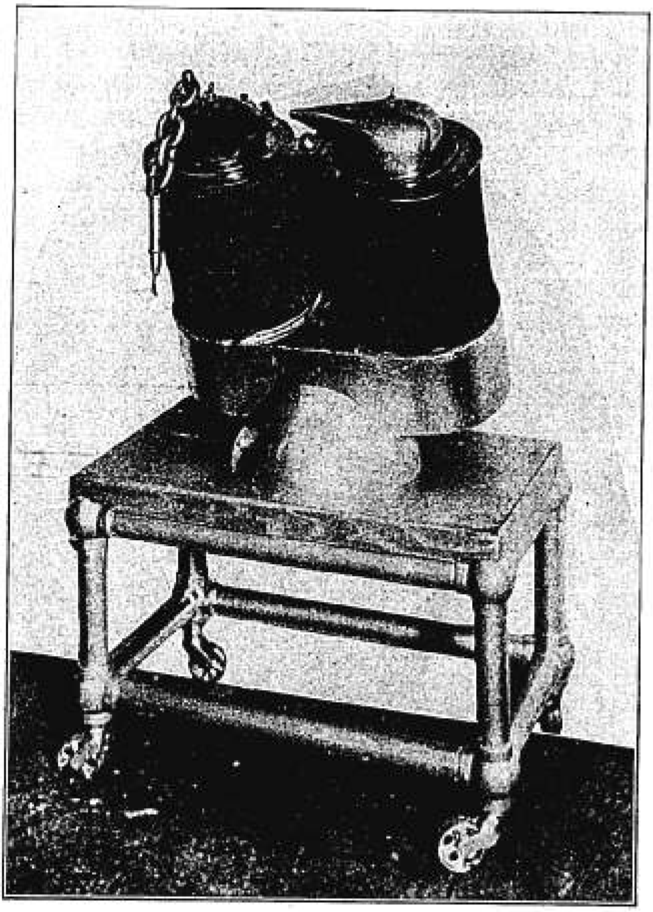

Figure 2. The giant-magnet of Dr. John Ranly.

The chain from the magnet was brought into contact with the bar and the current turned on. The operating table and patient were then slowly pulled away from the magnet and the steel emerged from the trachea with the screw dangling on the end. The screw was badly corroded and measured ¾ of an inch (2 cm.) in length. (Figure 4.)

Subsequent History: The tracheal canula was first left out, but it became necessary to re-introduce it the same night. It was worn for twenty-four days thereafter, since expectoration continued profuse, and could be readily expelled through the canula. Following the removal of the foreign body the patient gradually improved and gained in weight, while the expectoration diminished for several weeks, only to increase again after that.

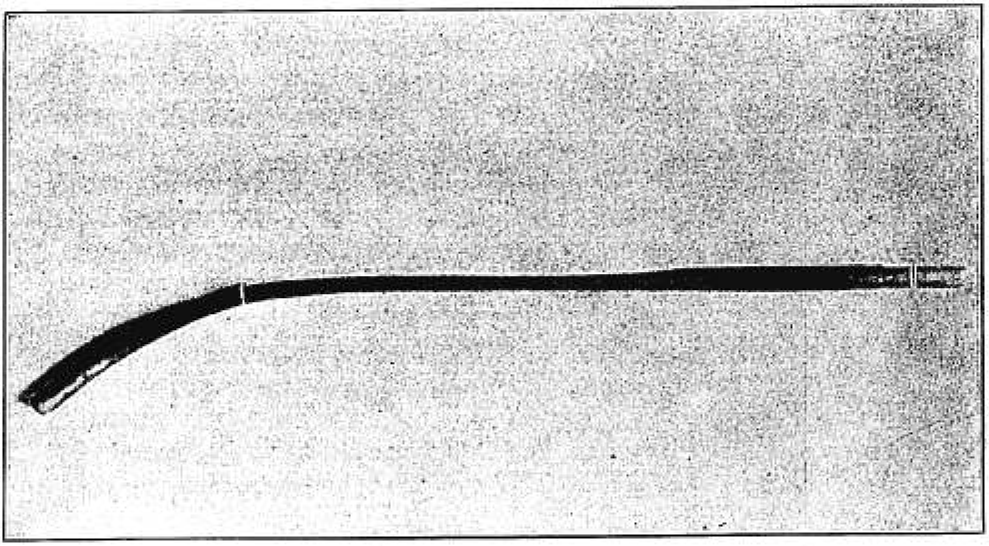

Figure 3. Steel rod which was magnetized and with which the screw was attracted and extracted.

Six months after the foreign body had been removed, the lung still remaining consolidated, (slight fever, profuse expectoration, etc.). It was decided to drain the abscess externally. This was done by Dr. Langdale. A second drainage operation became necessary three months later.

At the present time, the wound is still discharging somewhat; expectoration has almost ceased, and the patient has gained 15½ pounds in all.

Remarks: The unusual features of this case were the length of time the foreign body had been *in situ* and its accidental discovery by the x-ray after the diagnosis of abscess of the lung had been made. The ease with which magnetic extraction was accomplished after bronchoscopy had failed is also worthy of note.

Case 2: The following case is as interesting as Case 1. Miss D. J., aged, 19, was seen in consultation with Dr. Mithoefer on October 1, 1912. She stated that a few hours before she had put some pins in her mouth and had choked on one of them. Some one in the factory where she worked had attempted to extract the pin with her fingers, but to no avail. Laryngoscopic examination at first failed to show the pin. A radiogram was therefore taken by Dr. Lange, and this revealed the pin behind the epiglottis.

The laryngoscope then showed the foreign body in a vertical position immediately behind the epiglottis, with the head of the pin resting at the anterior commissure and the tip embedded loosely in the epiglottis. It seemed as if the pin might at any moment topple off into the trachea.

Upon request the patient produced a pin which she declared was identical with the one she had swallowed. This companion pin proved to be easily magnetized, and it was explained to the patient that we desired to extract the pin with a magnet, as I feared that the forceps might easily dislodge the foreign body.

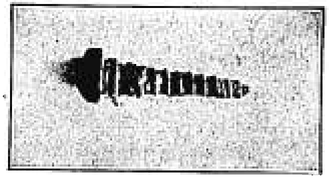

Figure 4. The foreign body, actual size, removed by magnetic attraction.

The patient was taken to the office of Dr. Ranly. The larynx was cocainized (by the drop method) and a curved steel bar was being magnetized by contact with the magnet. The first attempt failed and upon a second attempt the pin, much to our chagrin, became dislodged and disappeared.

A radiogram immediately thereafter showed the pin in a lower division of the left bronchus. The following day, assisted by Dr. Murphy and Dr. Mithoefer, I made a prolonged search for the pin by upper bronchoscopy, but it could not be found.

On October 4, 1912, Dr. Murphy and I took the patient to Pittsburg, to consult Dr. Chevalier Jackson, who considered it a very difficult case. He made a prolonged bronchoscopic search for the foreign body, but was unable to find it. A few days later he made a second unsuccessful search for the pin. On October 12, 1912, the patient developed pneumo-thorax. Dr. Hartley Anderson thereupon removed the pin from the lung through an external operation. The pin, after its removal, was tested with a magnet, *but could not be magnetized.* The patient recovered, and in a few weeks the lung had fully expanded.

Remarks: In this case extraction with a magnet seemed a perfectly rational procedure, but I was led astray by the companion pin which the patient presented. The failure in this case was as disappointing as was the satisfaction in the first case.

EXPERIMENTS ON ANIMALS.

In all the clinical cases heretofore recorded the magnet has been applied through a tracheotomy. De Roaldes,[13] in a series of experiments on the cadaver, was unable to guide an object from the trachea through the larynx into the mouth. He suggested the use of two magnets, one to be applied over the trachea and the other to be introduced into the mouth.

In some recent experiments, assisted by Dr. Ranly, I have undertaken the direct extraction of magnetizable bodies from the trachea and bronchi of dogs, by the attraction of magnetized steel rods, *introduced through the larynx,* into the deeper air-passages.

Four dogs were used, one of these was a dead animal and three were living, anesthetized animals. (One of the latter died after three experiments had been performed.)

The procedure was as follows: A foreign body, (nail, bolt, screw or needle) was introduced through a bronchoscope into the lower trachea or into a bronchus. The bronchoscope was then removed and a steel rod was passed through the larynx into the deeper air-passages. In order to attract the foreign body, the rod was then magnetized by contact with the electro-magnet.

At different times, fifteen objects were in this manner introduced through the larynx, while one was inserted through a tracheotomy. Of the fifteen foreign bodies, six were recovered *per vias naturales* and two through a tracheotomy. Since the rods were of smaller diameter than the trachea the animals were not asphyxiated when the rods were introduced. The foreign body introduced through the trachea could not be recovered. Of the total number of objects recovered, all but one were from live animals, and of the eight objects recovered, four had been in the bronchi, and four in the trachea.

Prota[14] records some similar experiments, all of which, however, were performed through the open trachea of the animals.

From the results of his experiments as well as from my own, the conclusion may be drawn that the metallic bodies must be free, or very loosely impacted in the trachea-bronchial tract if it is to be extracted by a magnet.

Jackson's[15] article contains a similar conclusion.

In exceptional instances, in human beings, it might be possible to combine suspension laryngoscopy and magnetic attraction by means of steel rods passed through the suspension laryngoscope, corresponding to the experiments on animals recorded above.

A review of the recorded clinical cases, as well as of my own, leads to the conclusion that in exceptional instances the electromagnet may prove of great value in the extraction of foreign bodies from the lungs. These cases would be limited to that group in which the foreign body was beyond the reach of a bronschoscope or was concealed in profuse secretions. The magnet may also attract the foreign body and thereby shorten the search when an external operation becomes necessary. In the vast majority of instances, however, the bronchoscope will remain the instrument of choice.

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